

## 2-Channel Voltage Detectors

## ■ GENERAL DESCRIPTION

The XC612 series consist of 2 voltage detectors, in 1 mini-molded, SOT-25 package.

The series provides accuracy and low power consumption through CMOS processing and laser trimming and consists of a highly accurate voltage reference source, 2 comparators, hysteresis and output driver circuits.

The input ( $V_{IN1}$ ) for voltage detector 1 ( $V_{D1}$ ) dually functions as the power supply pin for both detector 1 ( $V_{D1}$ ) and detector 2 ( $V_{D2}$ ).

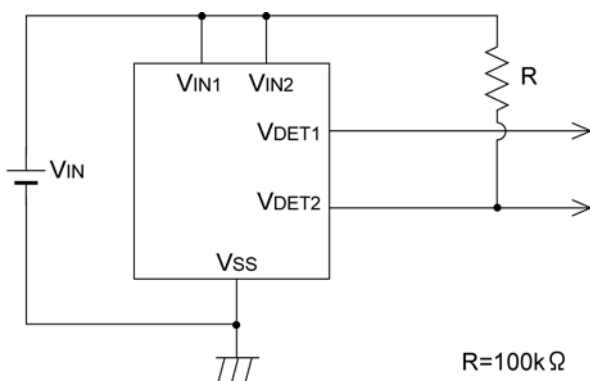
## ■ APPLICATIONS

- Microprocessor reset circuitry
- Memory battery back-up circuits
- Power-on reset circuits
- Power failure detection
- System battery life and charge voltage monitors
- Delay circuitry

## ■ FEATURES

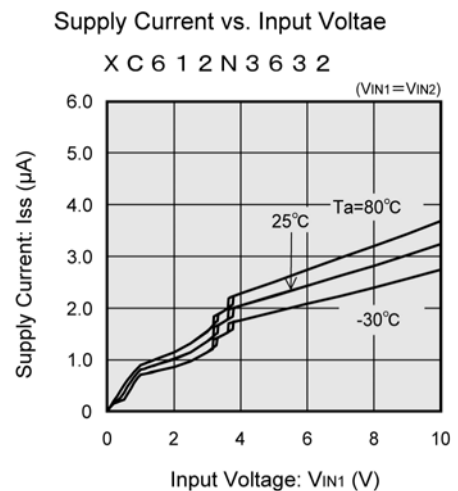
- Detect voltage accuracy** :  $\pm 2\%$
- Low Power Consumption** :  $2.0 \mu\text{A}$  (TYP.)  
( $V_{IN1}=V_{IN2}=2.0\text{V}$ , Static state)
- Detect Voltage** :  $1.5\text{V} \sim 5.0\text{V}$  programmable in  $100\text{mV}$  steps. Detector's voltages can be set-up independently  
Conditionally;  
XC612N :  $V_{DET1} > V_{DET2}$   
XC612D, XC612E :  $V_{DET1} \geq V_{DET2}$ ,  
 $V_{DET1} < V_{DET2}$
- Operating Voltage Range** :  $1.5\text{V} \sim 10.0\text{V}$
- Temperature Characteristics** :  $\pm 100\text{ppm}/^\circ\text{C}$  (TYP.)
- Output Configuration** : N-channel open drain, CMOS
- Operating Ambient Temperature** :  $-40^\circ\text{C} \sim +85^\circ\text{C}$
- Packages** : SOT-25, USP-6B
- Environmentally Friendly** : EU RoHS Compliant, Pb Free

## ■ TYPICAL APPLICATION CRICUIT



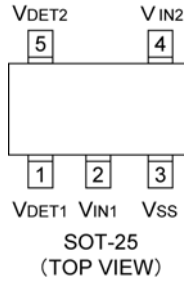
$V_{DET1}$  : CMOS,  $V_{DET2}$  : N-ch Open drain

## ■ TYPICAL PERFORMANCE CHARACTERISTICS

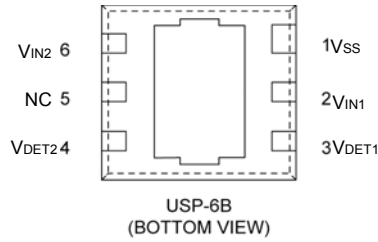


## PIN CONFIGURATION

### ●SOT-25



### ●USP-6B



\* The dissipation pad for the USP-6B package should be solder-plated in recommended mount pattern and metal masking to enhance mounting strength and heat release. If the pad needs to be connected to other pins, it should be connected to the  $V_{IN}$  level.

## PIN ASSIGNMENT

| PIN NUMBER |        | PIN NAME   | FUNCTION                       |
|------------|--------|------------|--------------------------------|
| SOT-25     | USP-6B |            |                                |
| 1          | 3      | $V_{DET1}$ | Voltage Detector 1 Output      |
| 2          | 2      | $V_{IN1}$  | Detector 1 Input, Power Supply |
| 3          | 1      | $V_{SS}$   | Ground                         |
| 4          | 6      | $V_{IN2}$  | Voltage Detector 2 Input       |
| 5          | 4      | $V_{DET2}$ | Voltage Detector 2 Output      |
| -          | 5      | NC         | No Connect                     |

## PRODUCT CLASSIFICATION

### ●Selection Guide

| TYPE   | $V_{DET1}$      | $V_{DET2}$      |
|--------|-----------------|-----------------|
| XC612N | N-ch Open Drain | N-ch Open Drain |
| XC612D | N-ch Open Drain | CMOS            |
| XC612E | CMOS            | N-ch Open Drain |

### ●Ordering Information

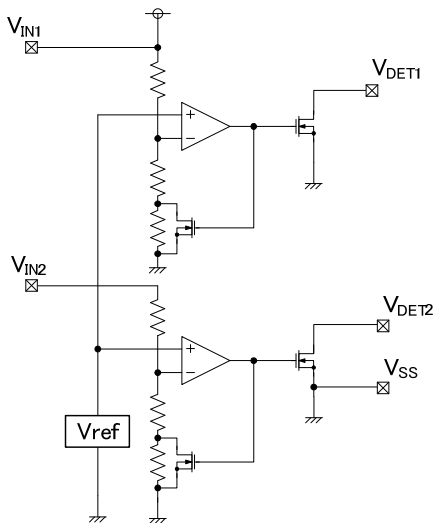
XC612①②③④⑤⑥⑦

| DESIGNATOR | ITEM                          | SYMBOL | DESCRIPTION                 |
|------------|-------------------------------|--------|-----------------------------|
| ①          | Type                          | N      | Refer to selection guide    |
|            |                               | D      |                             |
|            |                               | E      |                             |
| ②③         | Detect voltage ( $V_{DET1}$ ) | 15~50  | $V_{DET1}$ e.g. 2.5V→②2, ③5 |
| ④⑤         | Detect Voltage ( $V_{DET2}$ ) | 15~50  | $V_{DET2}$ e.g. 3.3V→②3, ③3 |
| ⑥⑦-⑧       | Packages (Order Unit)         | MR     | SOT-25(3,000/Reel)          |
|            |                               | MR-G   | SOT-25(3,000/Reel)          |
|            |                               | DR     | USP-6B(3,000/Reel)          |
|            |                               | DR-G   | USP-6B(3,000/Reel)          |

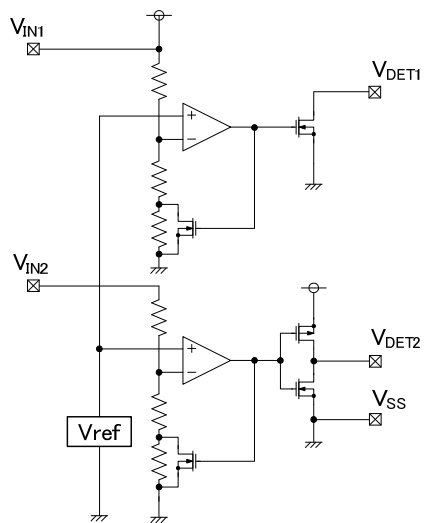
<sup>(1)</sup> The "-G" suffix indicates that the products are Halogen and Antimony free as well as being fully RoHS compliant.

**■ BLOCK DIAGRAMS**

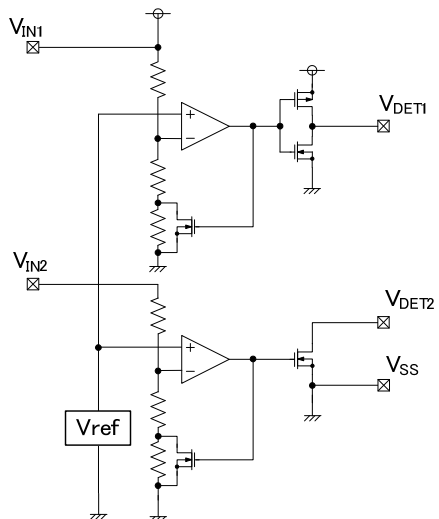
XC612N Series



XC612D Series



XC612E Series



## ■ ABSOLUTE MAXIMUM RATINGS

Ta = 25°C

| PARAMETER                     |                                    | SYMBOL            | RATINGS  | UNITS |
|-------------------------------|------------------------------------|-------------------|--|-------|
| Input Voltage                 | V <sub>IN1</sub>                   | V <sub>IN1</sub>  | V <sub>SS</sub> -0.3~V <sub>SS</sub> +12                         | V     |
|                               | V <sub>IN2</sub> N                 | V <sub>IN2</sub>  | V <sub>SS</sub> -0.3~V <sub>IN1</sub> +0.3                       | V     |
|                               | V <sub>IN2</sub> D/E               |                   | V <sub>SS</sub> -0.3~V <sub>SS</sub> +12                         |       |
| Output Voltage                | V <sub>DET1</sub> (Nch open drain) | V <sub>DET1</sub> | V <sub>SS</sub> -0.3~V <sub>SS</sub> +12                         | V     |
|                               | V <sub>DET1</sub> (CMOS)           | V <sub>DET1</sub> | V <sub>SS</sub> -0.3~V <sub>IN1</sub> +0.3 ≤ V <sub>SS</sub> +12 | V     |
|                               | V <sub>DET2</sub> (Nch open drain) | V <sub>DET2</sub> | V <sub>SS</sub> -0.3~V <sub>SS</sub> +12                         | V     |
|                               | V <sub>DET2</sub> (CMOS)           | V <sub>DET2</sub> | V <sub>SS</sub> -0.3~V <sub>IN1</sub> +0.3 ≤ V <sub>SS</sub> +12 | V     |
| Output Current                | V <sub>DET1</sub>                  | I <sub>DET1</sub> | 50   | mA    |
|                               | V <sub>DET2</sub>                  | I <sub>DET2</sub> | 50   | mA    |
| Power Dissipation             | SOT-25                             | Pd                | 250  | mW    |
|                               | USP-6B                             |                   | 120  |       |
| Operating Ambient Temperature |                                    | Topr              | -40~+85  | °C    |
| Storage Temperature           |                                    | Tstg              | -55~+125   | °C    |

## ■ ELECTRICAL CHARACTERISTICS

Ta=25°C

| PARAMETER  | SYMBOL  | CONDITIONS  |                         | MIN.                          | TYP.                       | MAX.                          | UNITS  | CIRCUITS |
|--|---|---|-------------------------|-------------------------------|----------------------------|-------------------------------|--------|----------|
| Detect Voltage (V <sub>DET1</sub> )                                  | V <sub>DF1</sub>                                      | Voltage when V <sub>DET1</sub> changes from H to L following a reduction of V <sub>IN1</sub>  |                         | V <sub>DF1(T)</sub><br>x 0.98 | V <sub>DF1(T)</sub>        | V <sub>DF1(T)</sub><br>x 1.02 | V      | ①        |
| Detect Voltage (V <sub>DET2</sub> )                                  | V <sub>DF2</sub>                                      | Voltage when V <sub>DET2</sub> changes from H to L following a reduction of V <sub>IN2</sub>  |                         | V <sub>DF2(T)</sub><br>x 0.98 | V <sub>DF2(T)</sub>        | V <sub>DF2(T)</sub><br>x 1.02 | V      | ①        |
| Hysteresis Range 1   | V <sub>HYS1</sub>                                     | Voltage (V <sub>DR1</sub> ) - V <sub>DF1</sub> when V <sub>DET1</sub> changes from L to H following an increase of V <sub>IN1</sub> |                         | V <sub>DF1</sub><br>x 0.02    | V <sub>DF1</sub><br>x 0.05 | V <sub>DF1</sub><br>x 0.08    | V      | ①        |
| Hysteresis Range 2   | V <sub>HYS2</sub>                                     | Voltage (V <sub>DR2</sub> ) - V <sub>DF2</sub> when V <sub>DET2</sub> changes from L to H following an increase of V <sub>IN2</sub> |                         | V <sub>DF2</sub><br>x 0.02    | V <sub>DF2</sub><br>x 0.05 | V <sub>DF2</sub><br>x 0.08    | V      | ①        |
| Supply Current (V <sub>IN1</sub> Input Current)                      | I <sub>SS</sub>                                       | V <sub>IN</sub> =V <sub>IN1</sub>   | V <sub>IN1</sub> = 1.5V | -                             | 1.35                       | 3.90                          | μA     | ②        |
|  |   |   | =2.0V                   | -                             | 1.50                       | 4.50                          |        |          |
|  |   |   | =3.0V                   | -                             | 1.95                       | 5.10                          |        |          |
|  |   |   | =4.0V                   | -                             | 2.40                       | 5.70                          |        |          |
|  |   |   | =5.0V                   | -                             | 3.00                       | 6.30                          |        |          |
| V <sub>IN2</sub> Input Current                                       | I <sub>IN2</sub>                                      | V <sub>IN</sub> =V <sub>IN1</sub> =V <sub>IN2</sub>   | V <sub>IN2</sub> = 1.5V | -                             | 0.45                       | 1.30                          | μA     | ②        |
|  |   |   | =2.0V                   | -                             | 0.50                       | 1.50                          |        |          |
|  |   |   | =3.0V                   | -                             | 0.65                       | 1.70                          |        |          |
|  |   |   | =4.0V                   | -                             | 0.80                       | 1.90                          |        |          |
|  |   |   | =5.0V                   | -                             | 1.00                       | 2.10                          |        |          |
| Operating Voltage  | V <sub>IN1</sub>                                      | V <sub>DF(T)</sub> = 1.5V to 5.0V   |                         | 1.0                           | -                          | 10                            | V      | -        |
| Output Current <sup>(*)</sup>  | I <sub>DET</sub>                                      | N-ch, V <sub>DS</sub> =0.5V   | V <sub>IN1</sub> =1.0V  | 0.3                           | 2.2                        | -                             | mA     | ③        |
|  |   |   | =2.0V                   | 3.0                           | 7.7                        | -                             |        |          |
|  |   |   | =3.0V                   | 5.0                           | 10.1                       | -                             |        |          |
|  |   |   | =4.0V                   | 6.0                           | 11.5                       | -                             |        |          |
|  |   |   | =5.0V                   | 7.0                           | 13.0                       | -                             |        |          |
|  |   | P-ch (CMOS)<br>V <sub>DS</sub> =-2.1V   | =8.0V                   | -                             | -10.0                      | -2.0                          |        |          |
| Temperature Characteristics <sup>(*)</sup>                           | $\frac{\Delta V_{DF}}{(\Delta T_{opr} \cdot V_{DF})}$ | -40°C ≤ T <sub>opr</sub> ≤ 85°C   |                         | -                             | ±100                       | -                             | ppm/°C | ①        |
| Delay Time <sup>(*)</sup><br>(Release Voltage →<br>Output inversion) | t <sub>DLY</sub>                                      | (V <sub>DR</sub> → V <sub>DET</sub> inversion)  |                         | -                             | -                          | 0.2                           | ms     | ④        |

<sup>(\*)</sup> The Features of output current, temperature characteristics and delay time are common between V<sub>DET1</sub> and V<sub>DET2</sub>

Note:

V<sub>DF1(T)</sub>, V<sub>DF2(T)</sub> : Nominal detect voltage.

Release voltage (V<sub>DR</sub>) = V<sub>DF</sub> + V<sub>HYS</sub>

N type Input Voltage : please ensure that V<sub>IN1</sub> > V<sub>IN2</sub>

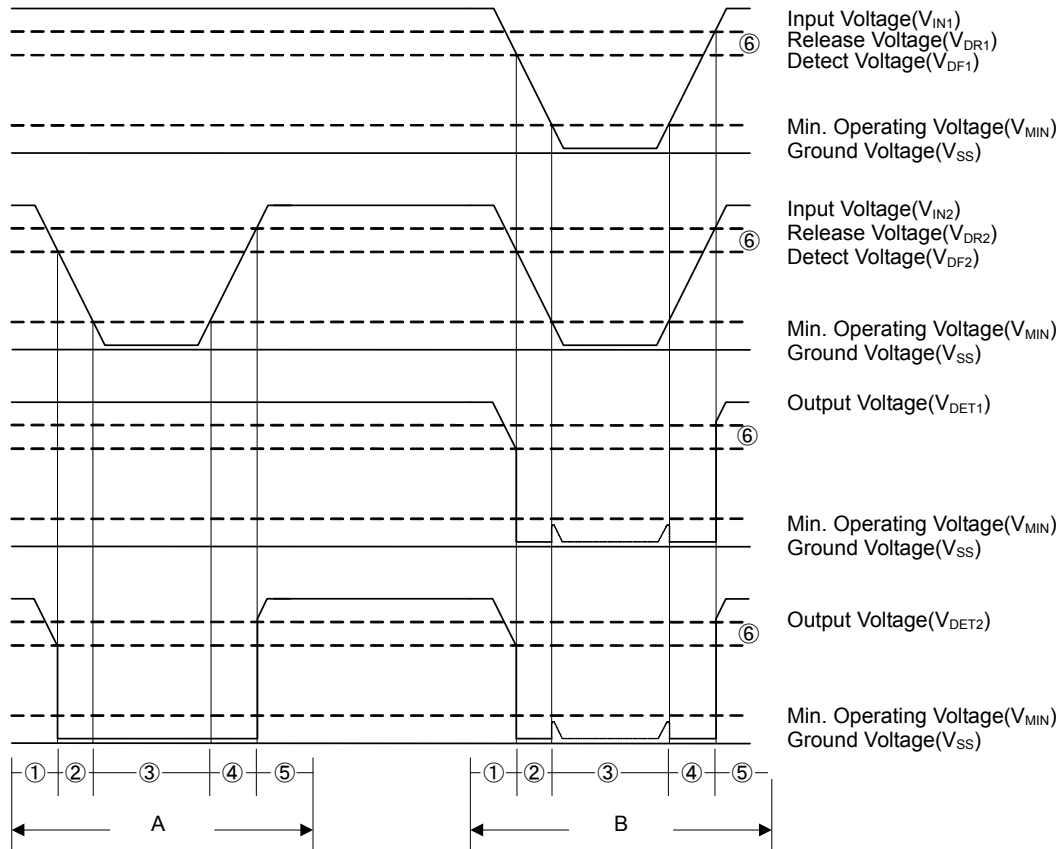
(Input voltage of XC612D and XC612E series : please ensure that V<sub>IN1</sub> ≥ V<sub>IN2</sub>, V<sub>IN1</sub> < V<sub>IN2</sub>.)

V<sub>IN1</sub> pin serve both I<sub>SS</sub> and power supply pin so that V<sub>IN2</sub> operates V<sub>IN1</sub> as a power supply source. For normal operation of V<sub>IN2</sub>, operating voltage higher than the minimum is needed to be applied to power supply pin V<sub>IN1</sub>.

For CMOS output products, high level output voltage which is generated when the transient response is released becomes input voltage of V<sub>IN</sub>.

## OPERATIONAL EXPLANATION

### ● Timing Chart (Pull up voltage = Input voltage $V_{IN1}$ )



### ● Operational Notes (N-ch Open drain)

#### Timing Chart A ( $V_{IN1}$ =voltages above release voltage, $V_{IN2}$ =sweep voltage)

Because a voltage higher than the minimum operating voltage is applied to the voltage input pin ( $V_{IN}$ ), ground voltage will be output at the output pin ( $V_{DET}$ ) during stage 3. (Stages 1, 2, 4, 5 are the same as in B below).

#### Timing Chart B ( $V_{IN1}=V_{IN2}$ )

- ① When a voltage greater than the release voltage ( $V_{DR}$ ) is applied to the voltage input pin ( $V_{IN1}$ ,  $V_{IN2}$ ), input voltage ( $V_{IN1}$ ,  $V_{IN2}$ ) will gradually fall.  
When a voltage greater than the detect voltage ( $V_{DF}$ ) is applied to the voltage input pin ( $V_{IN1}$ ,  $V_{IN2}$ ), a state of high impedance will exist at the output pin ( $V_{DET1}$ ,  $V_{DET2}$ ), so should the pin be pulled up, voltage will be equal to pull up voltage.
- ② When input voltage ( $V_{IN1}$ ,  $V_{IN2}$ ) falls below detect voltage ( $V_{DF}$ ), output voltage ( $V_{DET1}$ ,  $V_{DET2}$ ) will be equal to ground level ( $V_{SS}$ ).
- ③ Should input voltage ( $V_{IN1}$ ,  $V_{IN2}$ ) fall below the minimum operational voltage ( $V_{MIN}$ ), output will become unstable. Should  $V_{IN2}$  fall below  $V_{MIN}$ , voltage at the output pin ( $V_{DET2}$ ) will be equal to ground level ( $V_{SS}$ ) if the power supply ( $V_{IN1}$ ) is within the operating voltage range.  
\*In general the output pin is pulled up so output will be equal to pull up voltage.
- ④ Should input voltage ( $V_{IN1}$ ,  $V_{IN2}$ ) rise above ground voltage ( $V_{SS}$ ), output voltage ( $V_{DET1}$ ,  $V_{DET2}$ ) will equal ground level until the release voltage level ( $V_{DR}$ ) is reached.
- ⑤ When input voltage ( $V_{IN1}$ ,  $V_{IN2}$ ) rises above release voltage, the output pin's ( $V_{DET1}$ ,  $V_{DET2}$ ) voltage will be equal to the voltage dependent on pull up.

Note : The difference between release voltage ( $V_{DR}$ ) and detect voltage ( $V_{DF}$ ) is the Hysteresis Range ⑥.

## ■ NOTES ON USE

1. Please use this IC within the specified maximum absolute ratings, for temporary, transitional voltage drop or voltage rising phenomenon, the IC is liable to malfunction should the ratings be exceeded.
2. When use N type, please ensure that input voltage  $V_{IN2}$  is less than  $V_{IN1} + 0.3V$ . (refer to N.B. 1 below)
3. With a resistor  $R_{IN}$  connected between the  $V_{IN1}$  pin and the power supply, oscillation is liable to occur as a result of through current at the time of release. (refer to N.B. 2 below)
4. With a resistor  $R_{IN}$  connected between the  $V_{IN1}$  pin and the power supply,  $V_{IN1}$  pin voltage will fall as a result of the IC's supply current flowing through the  $V_{IN1}$  pin.
5. In order to stabilize the IC's operations, please ensure that the  $V_{IN1}$  pin's input frequency's rise and fall times are more than 5 msec/V.
6. Should the power supply voltage  $V_{IN1}$  exceed 6V, voltage detector 2's detect voltage ( $V_{DF2}$ ) and the release voltage ( $V_{DR2}$ ) will shift somewhat.
7. For CMOS output products, high level output voltage which is generated when the transient response is released becomes input voltage of  $V_{IN}$ .
8. Torex places an importance on improving our products and its reliability. However, by any possibility, we would request user fail-safe design and post-aging treatment on system or equipment.

## ● N.B.

1. Voltage detector 2's input voltage ( $V_{IN2}$ ) N Type.  
An input protect diode is connected from input detector 2's input ( $V_{IN2}$ ) to input detector 1's input. Therefore, should the voltage applied to  $V_{IN2}$  exceed  $V_{IN1}$ , current will flow through  $V_{IN1}$  via the diode. (refer to diagram1)
2. Oscillation as a result of through current  
Since the XC612 series are CMOS ICs, through current will flow when the IC's internal circuit switching operates (during release and detect operations). Consequently, oscillation is liable to occur as a result of drops in voltage at the through current's resistor ( $R_{IN}$ ) during release voltage operations. (refer to diagram 2)  
Since hysteresis exists during detect operations, oscillation is unlikely to occur.

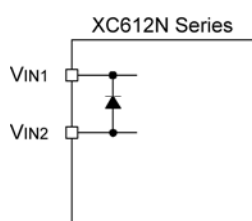


Diagram 1. Voltage detector 2's input voltage  $V_{IN2}$

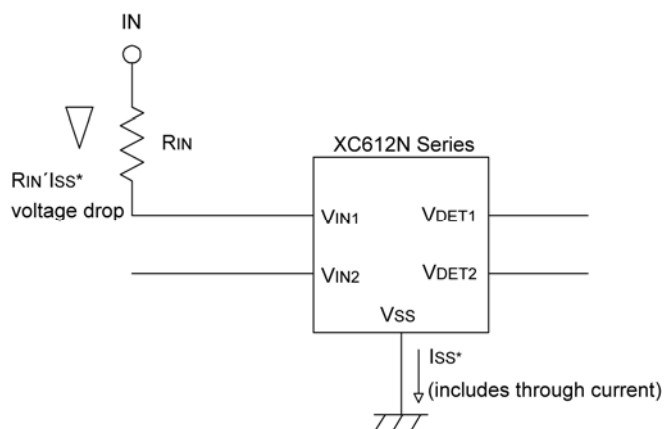
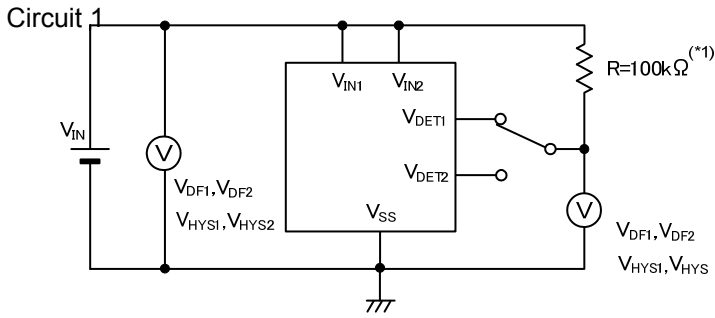


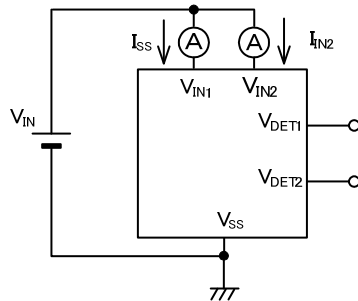
Diagram 2. Through current oscillation

## TEST CIRCUITS

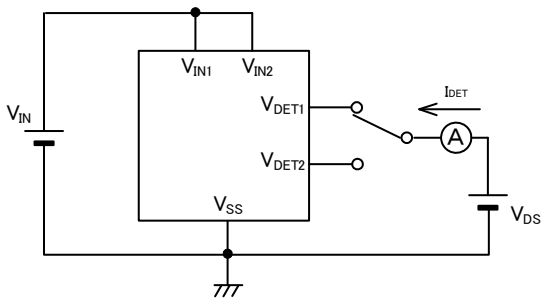


\* A resistor is not needed for CMOS output type.

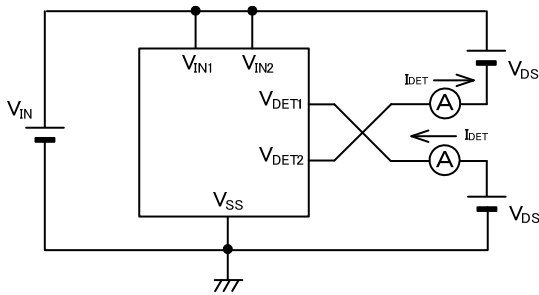
Circuit 2



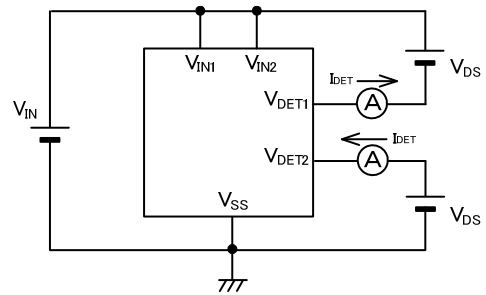
Circuit 3



XC612N Type



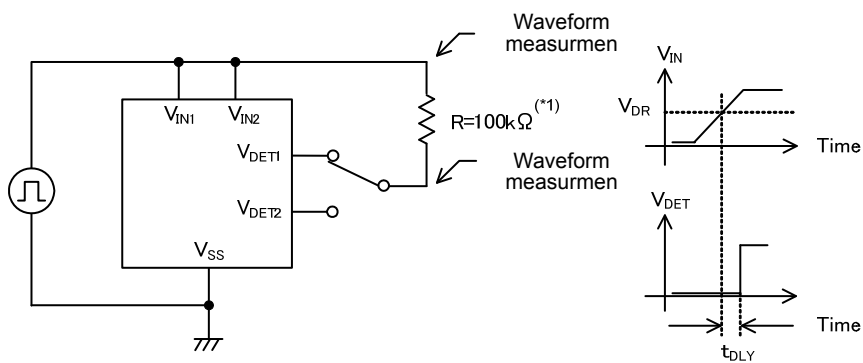
XC612D Type



XC612E Type

■ TEST CIRCUITS (Continued)

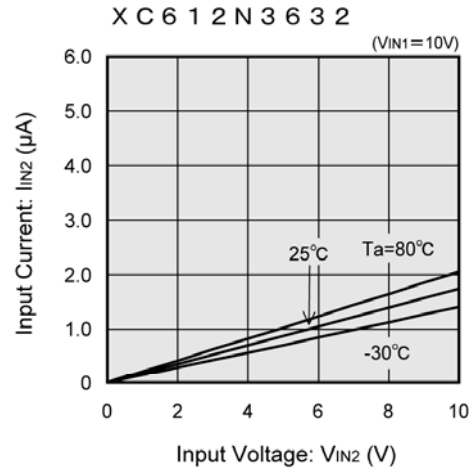
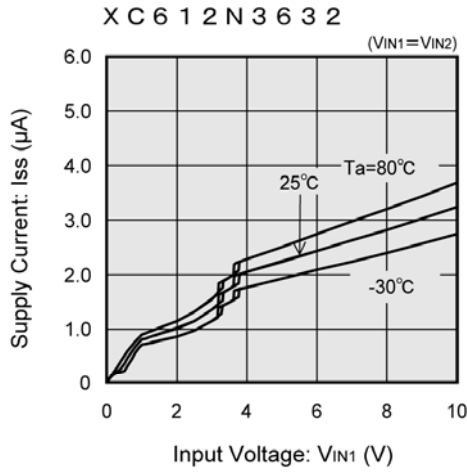
Circuit 4



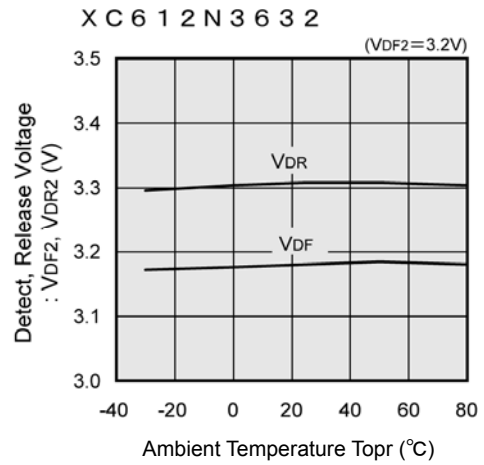
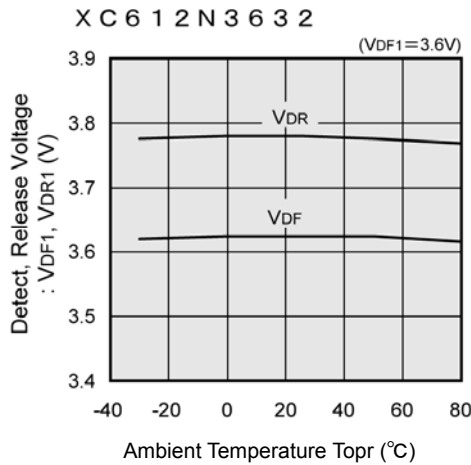
\* A resistor is not needed for CMOS output type.

## TYPICAL PERFORMANCE CHARACTERISTICS

(1) Supply Current vs. Input Voltage

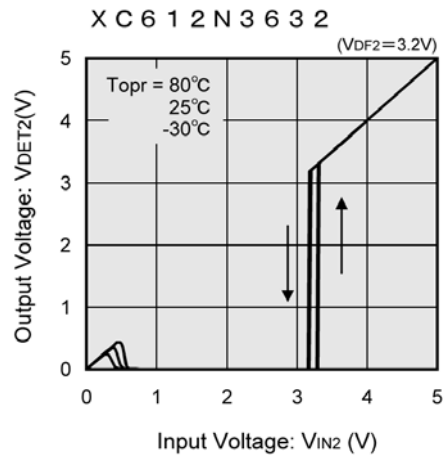
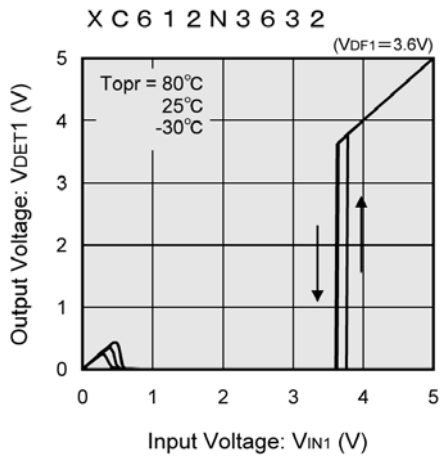


(2) Detect & Release Voltage vs. Ambient Temperature



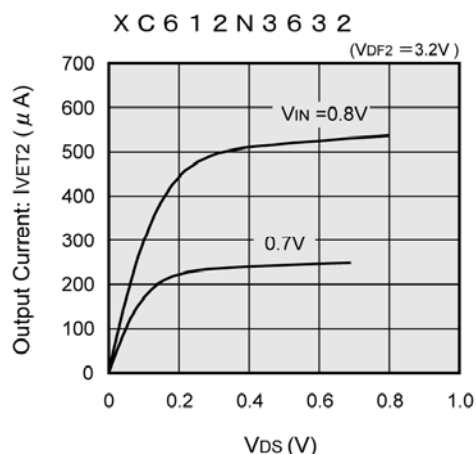
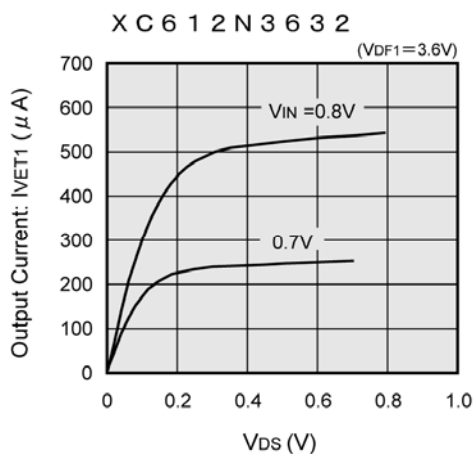
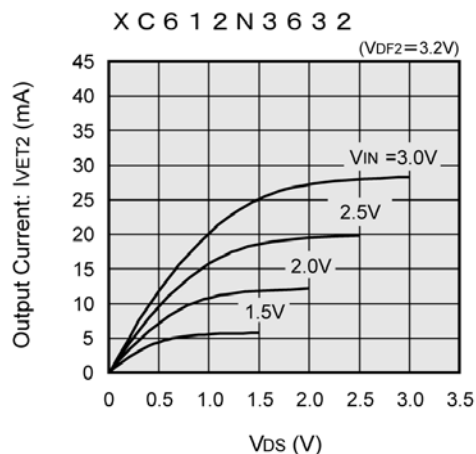
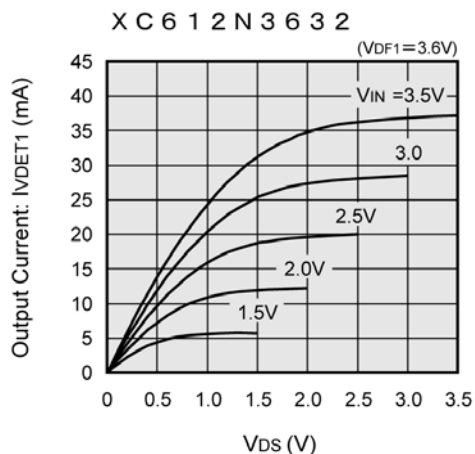
Note: Unless otherwise stated, pull up resistance = 100k $\Omega$  with N-ch open drain output type.

(3) Output Voltage vs. Input Voltage

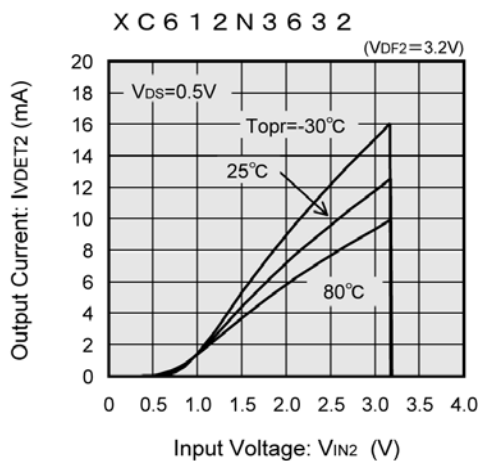
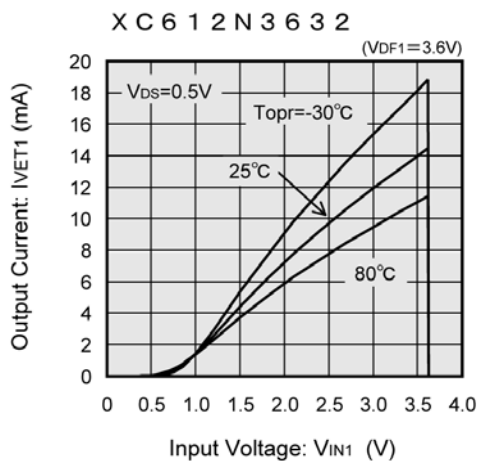


**■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)**

(4) N-ch Driver Output Current vs. V<sub>DS</sub>

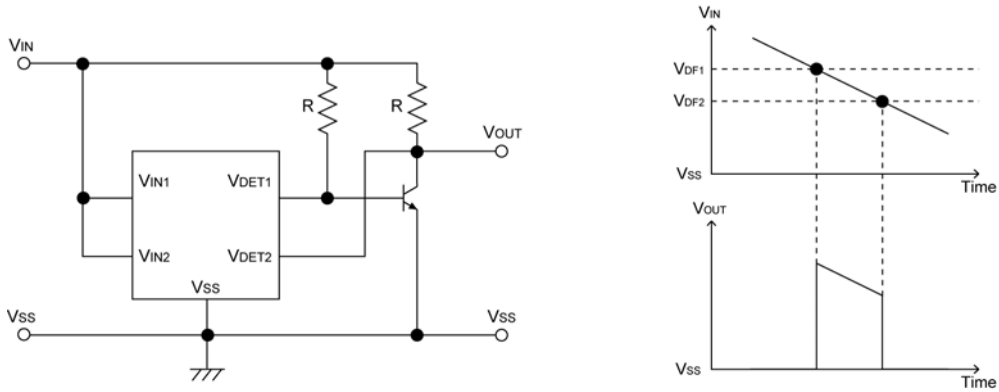


(5) N-ch Driver Output Current vs. Input Voltage

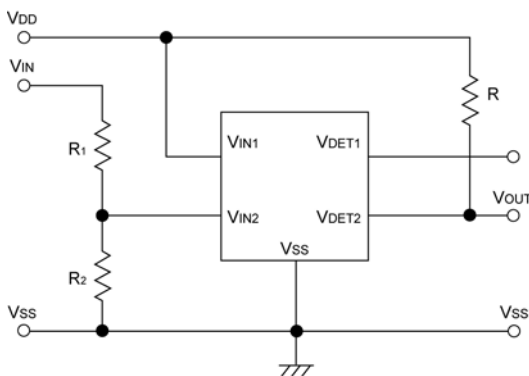


## APPLICATION CIRCUITS EXAMPLE \*Example covers N-channel open drain product's circuits

### ● Window comparator circuit



### ● Detect voltages above respective established voltages circuit



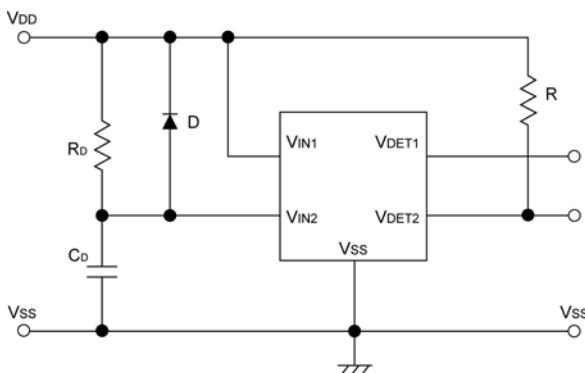
On resistors R1 and R2 equation (1) and (2)  
 Detect voltage =  $\{ (R1 + R2) \div R2 \} \times VDF2$  (1)

N.B.  $VDF2$  = detect voltage  $VD2$

Hysteresis ( $VHYS2$ ) =  $\{ (R1 + R2) \div R2 \} \times VHYS2$  (2)

Note: Please ensure that input voltage 2 ( $VIN2$ ) is less than  $VIN1 + 0.3V$

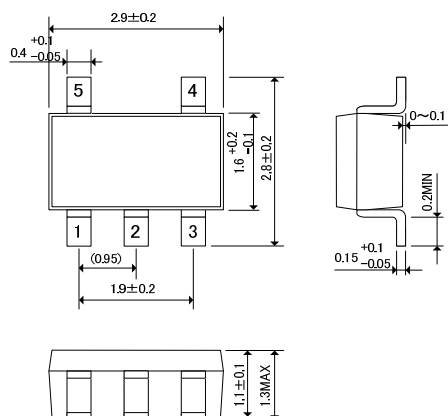
### ● Detect voltage circuit with delay built-in



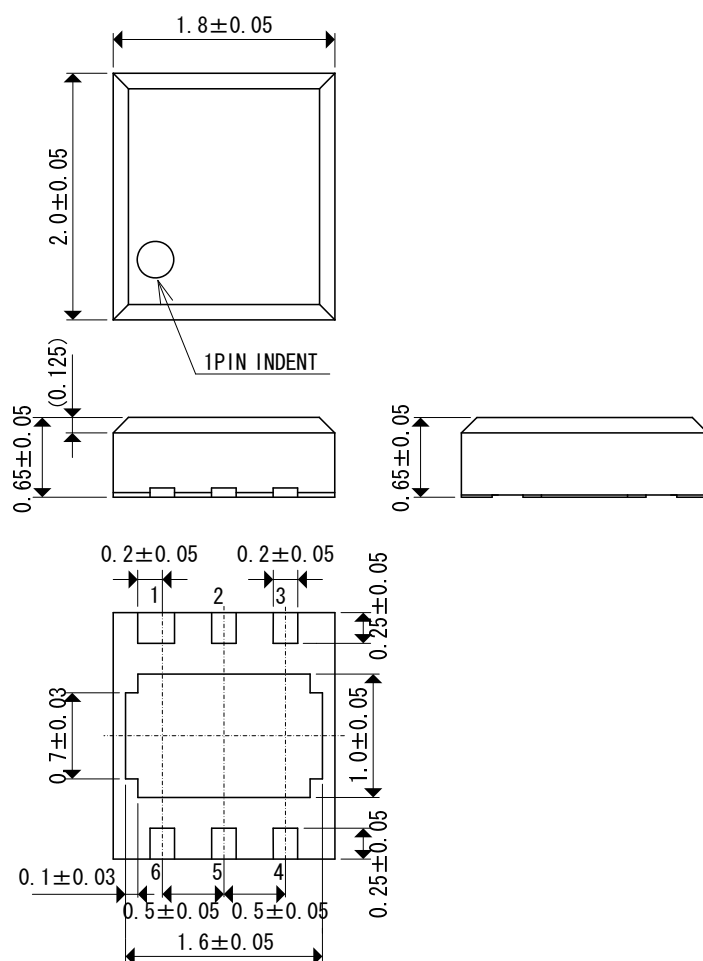
Note: Delay operates at both times of release and detect operations.

## PACKAGING INFORMATION

### ● SOT-25



### ● USP-6B





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